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UNION FIBRE COMPANY

INCORPORATED

ENGINEERS AND MANUFACTURERS

INSULATION

FOR COLD, HEAT, SOUND
MECHANICAL VIBRATION, CONDENSATION, ETC.

WINONA, MINNESOTA, U. S. A.

BULLETIN No. 1R

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SEPTEMBER, 1922

The Insulation of Roofs

FOR THE PREVENTION OF

Heat Loss and Condensation

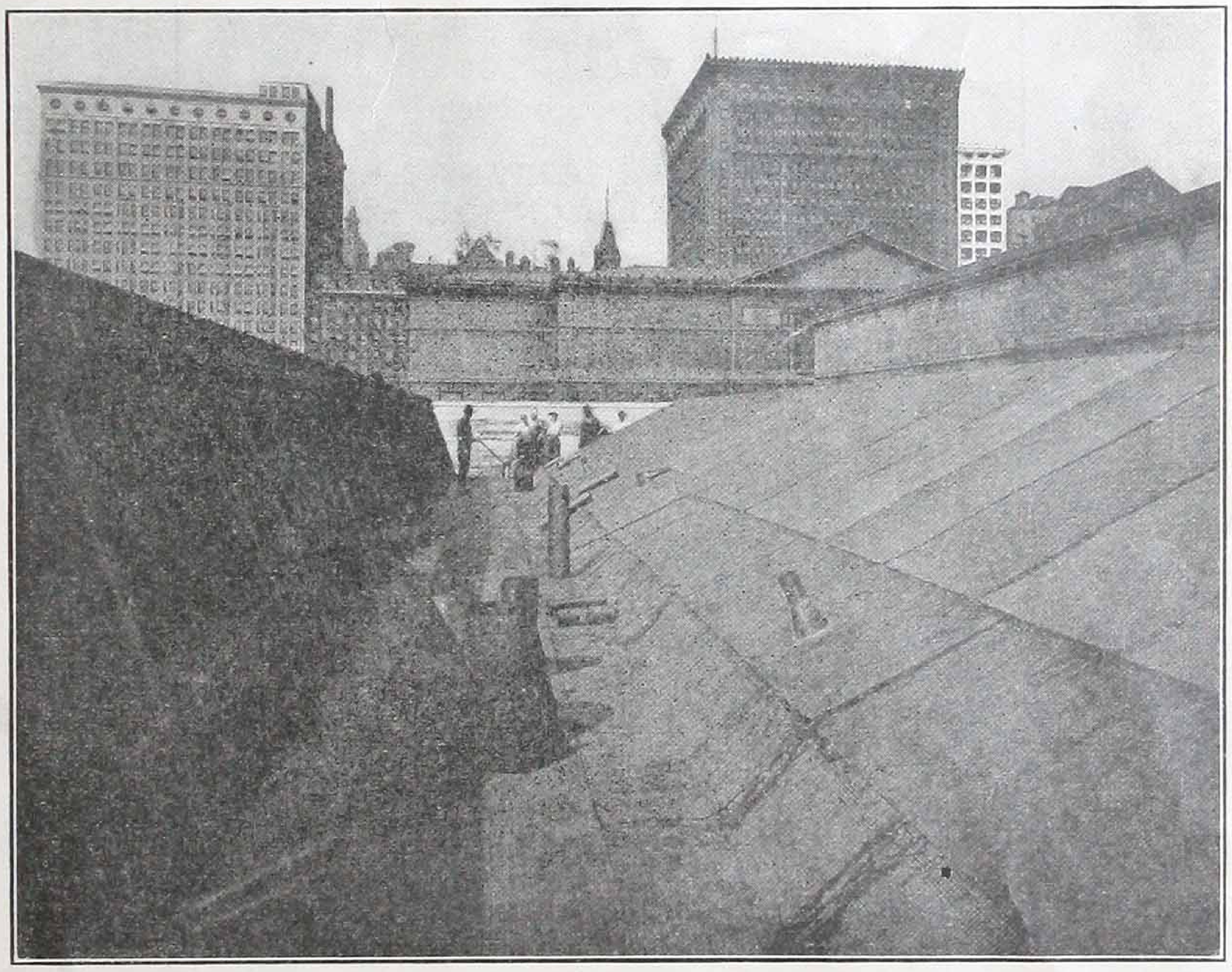

FIG. 1

Laying FIBROFELT Insulation
on roof of
Terrace Addition, Art Institute, Chicago, Ill.
Twelve sawteeth like one shown

We will gladly furnish, without charge or obligation, a scientific analysis showing the savings in fuel and radiation effected by the use of

INSULATION
in
ROOF, WALLS, FLOORS
of any type of building

UNION FIBRE COMPANY, Inc.
Engineers INSULATION Manufacturers
WINONA, MINNESOTA

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The Union Fibre Co., Incorporated has developed, from data accumulated during years of experience in the insulation field, a short method of solving all problems of roof insulation. By this method, the kind of insulation and the thickness required to prevent condensation on the inner surface of the roof under any conditions can be determined instantly.

It is also possible by the use of tabulated data to quickly calculate the saving in fuel and radiation effected by the use of insulation on a roof.

While this method of solving such problems was developed to save time in the Company's own offices, it is being published for the assistance and guidance of all parties interested in the efficient design of modern structures.

DESCRIPTION: Fig. 4 is Carrier's Psychrometric Chart which shows the relation between wet and dry bulb temperatures, relative humidity, dew point, etc. This chart was calculated by Mr. W. H. Carrier, and published in his paper entitled "Rational Psychrometric Formulae" which was presented before the American Society of Mechanical Engineers at the 1911 meeting. It is published in this Bulletin by courtesy of the Carrier Engineering Corporation, of Newark, N. J. By means of this chart it is possible to determine the allowable difference in temperature between the air in a building and the inner surface of the roof before condensation will occur on the under side of the roof. It is also possible to reverse this procedure and, knowing the difference in temperatures, find the greatest relative humidity that can be maintained under the roof before condensation will occur. The method of using this chart is explained later in an actual example.

It is evident that the temperature of the inner surface of the roof is dependent upon the amount of heat transmitted through the roof itself. By the use of standard formulae, and data obtained in tests made by the Bureau of Standards and other recognized authorities, it is possible to calculate the amount of heat transmitted through any roof under any existing conditions. It is also apparent that this transfer of heat through the roof is dependent upon a certain inherent resistance of the roof. This resistance, together with the corresponding heat transmission, has been calculated for various roofs and tabulated in Table 1. Surface effects have been taken into consideration in making these calculations.

The line "RR" in Fig. 5 is what has been termed the "Roof Resistance Curve." This curve was obtained by laying out the curve for each roof as indicated by No. 1 and No. 14, which are the curves for roofs of corresponding numbers in Table 1, and on each curve laying out the resistance of that particular roof, the resulting curve, established by connecting all of these points, is the straight line "RR."

Having determined the allowable difference in temperature from the Psychrometric Chart in Fig. 4, it is now possible by the use of the Resistance Curve and data contained in Table 1, to arrive at the kind of insulation and thickness necessary to prevent condensation on the inner surface of the roof for any given conditions, and having arrived at the insulation required, to calculate definitely the resulting saving in fuel and radiation. The method of arriving at these results is given in detail later, in an actual example.

It is easily seen that the Resistance Curve "RR" must be parallel to the vertical line "AA." This line "AA" would be the line for perfect insulation, or zero heat transmission, which it is, of course, impossible to ever realize. The Resistance Curve "RR" would therefore never meet the line "AA," which is the required condition for parallelism.

EXAMPLE

The following actual problem is worked out in detail to show the method of solution described above.

Type of Roof: Flat.

Materials and Construction: Five-ply tar and gravel roofing on 6″ concrete roof.

Area of Roof: 100′-0″ x 250′-0″, or 25,000 sq. ft.

Temperatures: Inside: 70 Degrees.
Outside: Minimum 10 degrees below zero.
Mean during heating season, 42 degrees.

Heating Season: 216 Days.

Humidity: 70% Relative humidity.

Dew Point: Referring to Fig. 4, we start at the inside dry bulb temperature of 70 degrees, and follow this line vertically upward until we strike the curve of 70% relative humidity. From this point we pass horizontally to the left to the curve of 100% relative humidity, or point of condensation. Passing from this point vertically downward, we find that the temperature at which condensation will occur, or as it is technically called, the dew point, is 59½ degrees. Subtracting this from the inside temperature of 70 degrees, we find an allowable drop in temperature of 10½ degrees, or in other words, the inner surface of the roof can be 10½ degrees colder than the air inside of the room before condensation will occur under the conditions given.

INSULATION REQUIRED: Turning to Fig. 5, we start on the lower horizontal line at the point indicated by 10½ degrees difference in temperature between the inner surface of the roof and the air in the room. From

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this point we pass vertically upward, as indicated by the dotted line, to the heat head of 80 degrees, which is the difference between the inside and outside temperatures. At this point we lay a straight edge to the lower left hand corner, similar to lines No. 1 and No. 14, and where this straight edge crosses the Resistance Curve "RR," we pass horizontally to the right, as indicated, and read the resistance required to meet the given conditions, which in this case is 5.750. Turning to Table 1, for roof No. 34, we find that this roof insulated with 1¼ inches of Fibrofelt will have a resistance of 6.088. This is the insulation therefore that should be used for the conditions given.

Saving Due to Insulation: Having established the kind and thickness of insulation required to prevent condensation, the saving due to such insulation can be calculated. It will be noted in Table No. 1 that the conductivity of the uninsulated roof is 0.436 B. t. u. per sq. ft., per degree difference in temperature, per hour, while the conductivity of the same roof insulated with 1¼ inches of Fibrofelt is given as 0.164 B. t. u. We therefore effect a saving of the difference between these two figures, or 0.272 B. t. u. per degree difference in temperature, per sq. ft., per hour.

With 70 degrees inside, and −10 degrees outside, the heat head, or difference in temperature, is 80 degrees. Therefore,

80 x 0.272 = 21.76 B. t. u. per sq. ft. per hour.

With a roof area of 25,000 sq. ft., we have

21.76 x 25,000 = 544,000 B. t. u. per hour saved by insulation.

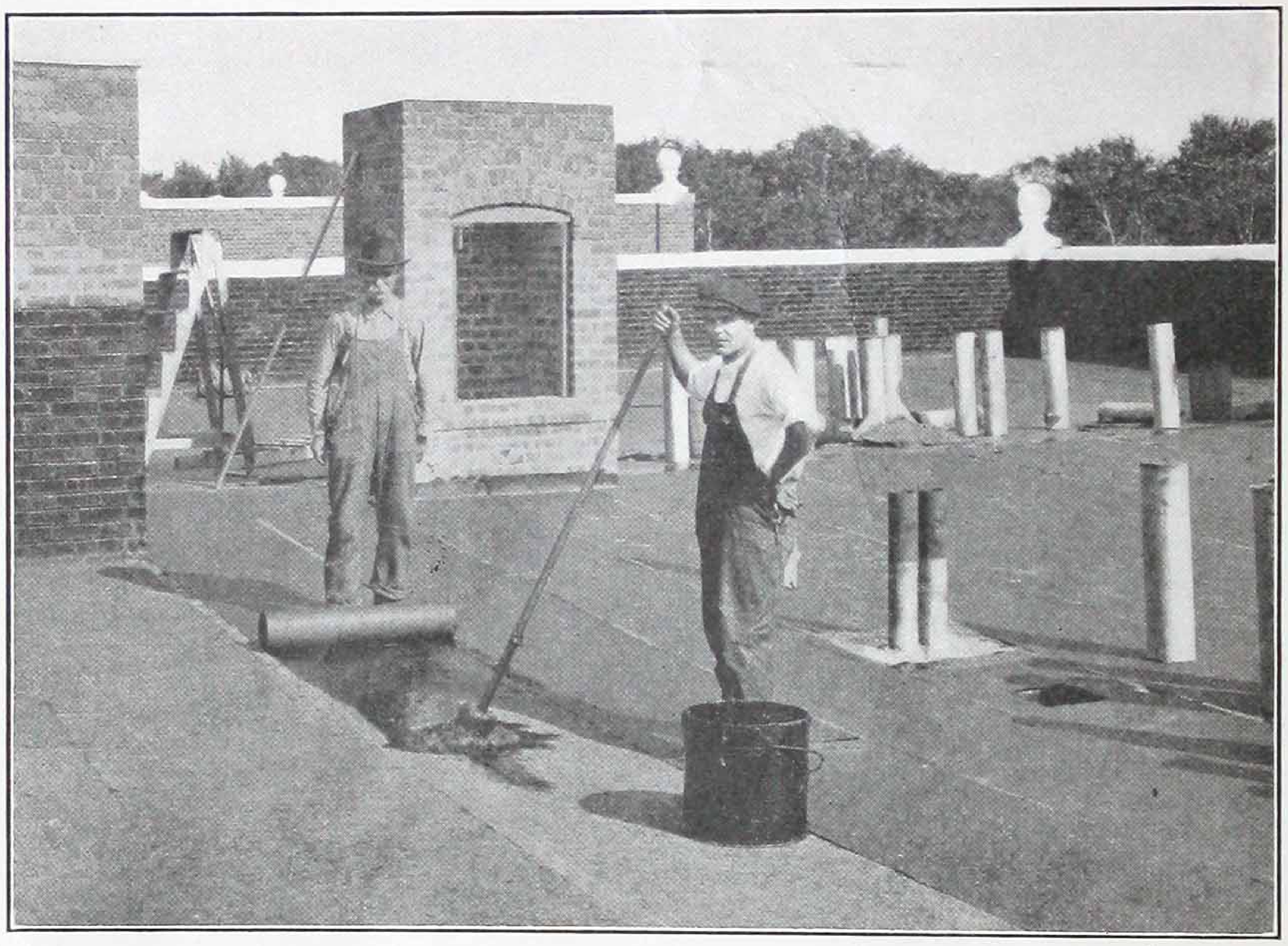


FIG. 2

Laying **FIBROFELT** Insulation on Roof on Newcomber Apartment Building, Cleveland, Ohio

Then,

$\frac{544,000}{960}$ = 567 lbs. of steam, or

$\frac{567}{8}$ = 71 lbs. of coal per hour.

We will assume that the building is heated to 70 degrees for twelve hours during the day and only 55 degrees for twelve hours during the night. With a mean temperature of 42 degrees outside and 70 degrees inside, only 35% of the maximum fuel demand will be used, and with 55 degrees inside, only 16.2% of the maximum demand will be used. Therefore,

35% of 71 x 12 hours = 298 lbs. of coal per day
16.2% of 71 x 12 hours = 138 lbs. of coal per night

Total 436 lbs. of coal per 24 hours.

436 x 216 days = 94,176 lbs., or 47 tons of coal saved per season.

Radiation:

$\frac{544,000}{240}$ = 2,266 sq. ft. of radiation saved by insulation.

Saving in Money:

47 Tons of coal @ $8.00 per ton*..........	$ 376.00
2,266 sq. ft. radiation @ $1.25*..........	2,832.50
Total saving..........................	$3,208.50

* These unit costs will of course vary in different locations.

By similar calculations, any problem in roof insulation can be solved.

If we have a particular roof and desire to find what maximum humidity can be carried in the building before condensation will occur, the process can be reversed as follows:

Assuming that we have the same roof used in the preceding example, which is roof No. 34 in Table 1, with $1\frac{1}{4}$ inches of Fibrofelt insulation, and assuming the same heat head of 80 degrees, we start on the Resistance Curve "RR" at the height indicated by a resistance of 6.088 as given for this roof in Table 1. Laying a straight edge from the lower left hand corner, or zero, through this point on the Resistance Curve "RR," and following it up to a line of 80 degrees heat head, and from this point, vertically downward, we obtain a reading of $9\frac{1}{2}$ degrees as the allowable difference in temperature between the inner surface of the roof and the air in the room. Turning to the Psychrometric Chart in Fig. 4, and starting on the lower horizontal line at a dry bulb temperature of $60\frac{1}{2}$ degrees, which is the allowable minimum temperature of the inner surface of the roof, and passing vertically upward to the curve of 100% humidity, and horizontally to the right to the line of 70 degrees dry bulb temperature, we find this roof will support a humidity of approximately 73%.

Note: Beyond a thickness of $1\frac{1}{2}$ inches it is more economical to use **Lith** board than **Fibrofelt.**

General Comments on Roof Insulation: In cases where extreme humidity inside of the building results from the manufacturing process conducted in the building, it is impossible to entirely prevent condensation by insulation alone within economical limits of cost, just as it is impossible to prevent such condensation by ventilation alone. The removal of this moisture-laden air by artificial ventilation is a continuous source of expense in such plants as paper mills, etc. This operating expense, and also the initial installation expense, can be greatly reduced by the proper combination of insulation and ventilation.

By assuming several different thickness of insulation, and determining the maximum humidity which can be carried with each particular thickness, it is seen that a point is reached beyond which an increase in insulation is not justified by the results obtained. Taking the humidity at which this limit is most apparent as the basis, mechanical ventilation should be installed which will reduce the relative humidity inside of the building to a point slightly below that which the insulation determined upon will carry. It will be found that this amount of ventilation is greatly below the amount required when the roof is uninsulated.

The savings indicated in the examples worked out in this Bulletin are not the only real initial savings effected by the insulation. It has been common practice in the past, where no insulation was used on the roof, to build quite a large air space, from three to four feet in depth, between the ceiling and the roof in such buildings as

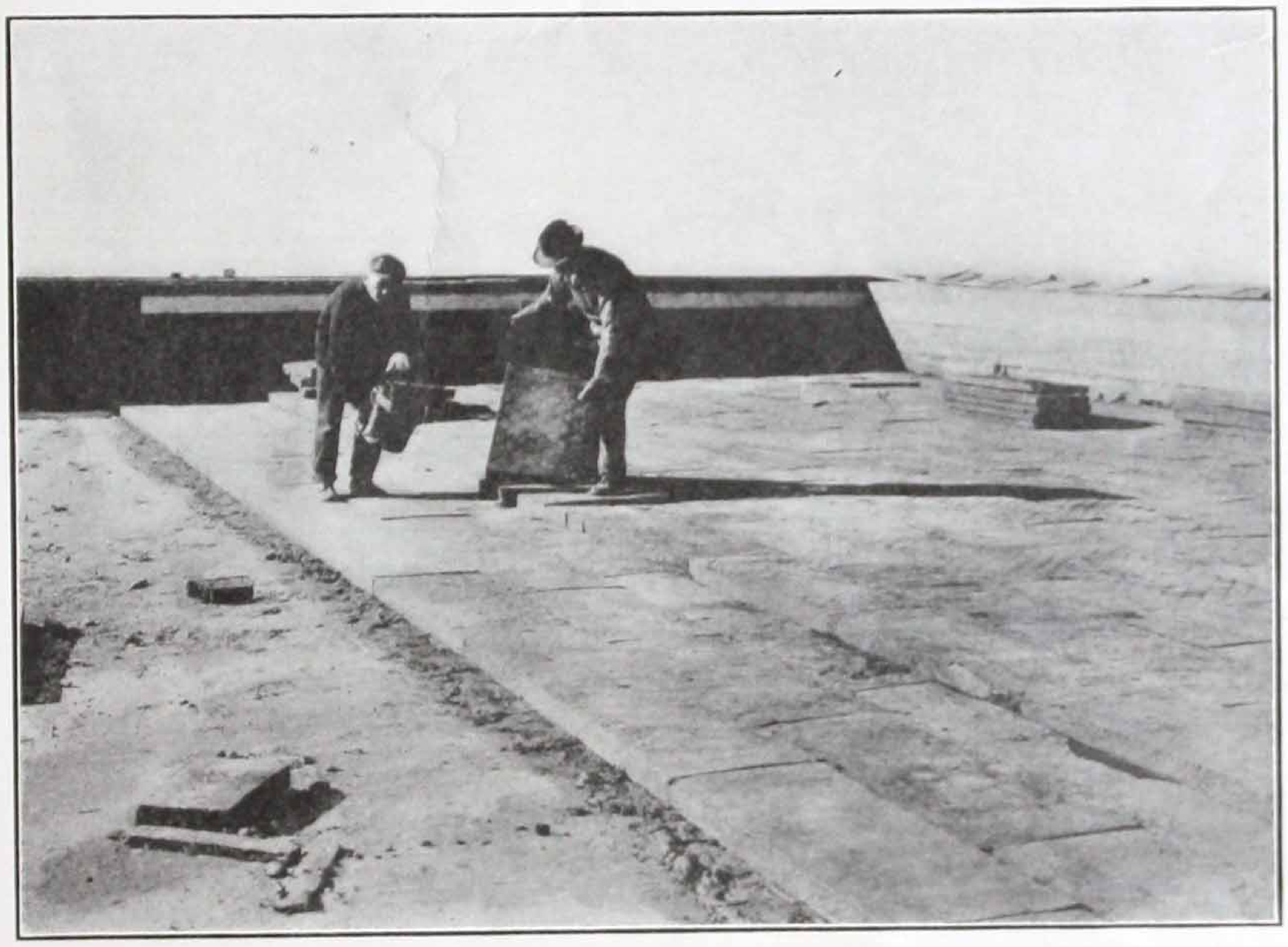
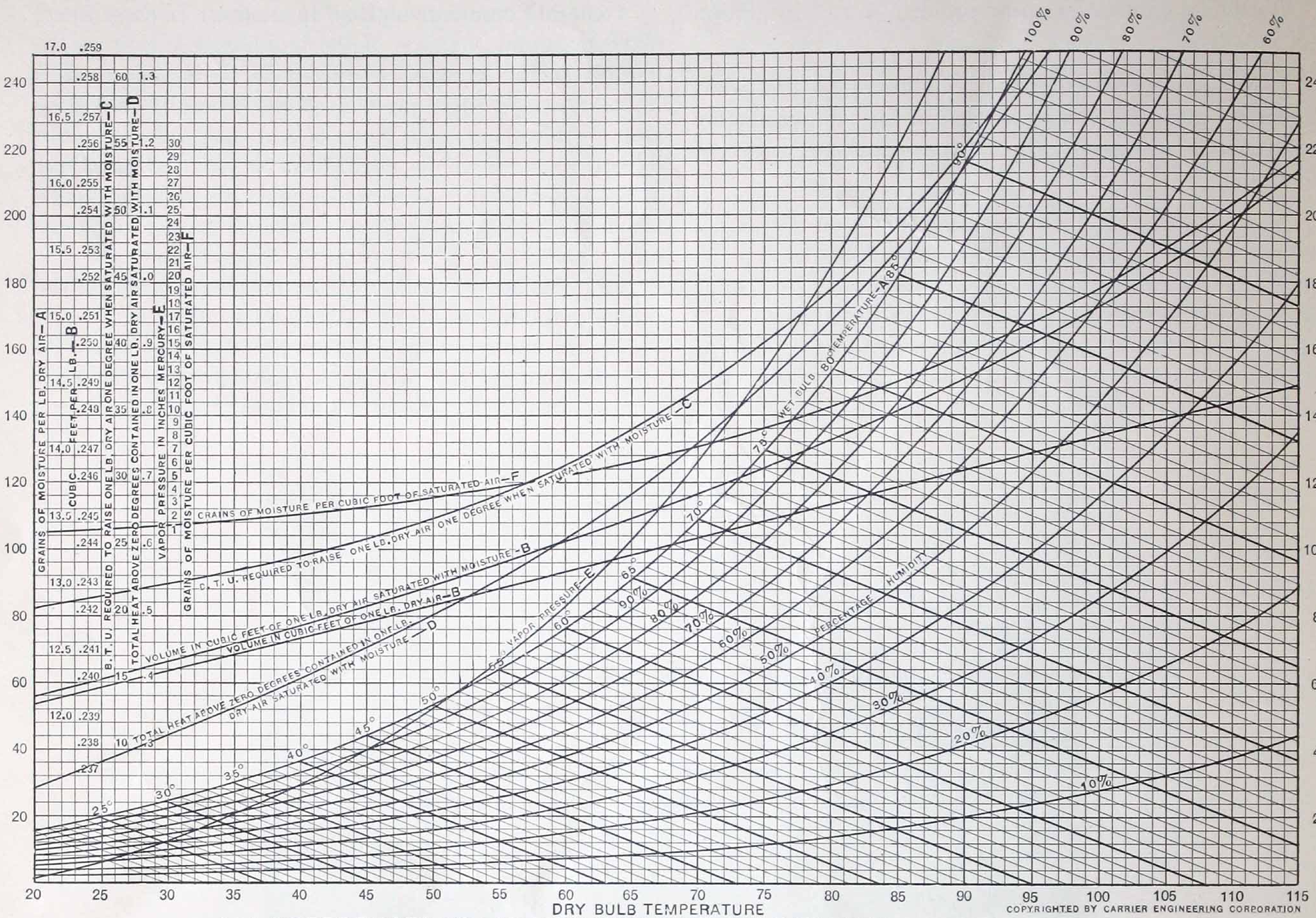


FIG. 3

Applying LITH Insulation to Roof



ALL REFERENCES TO TEMPERATURE ARE IN DEGREES FAHRENHEIT

FIG. 4

Psychrometric Chart

schools, apartment buildings, office buildings, hospitals, etc. All recognized authorities agree that the insulating value of an air space is very low, in fact, it is almost negligible. Therefore, by the use of the proper insulation on the roof, this air space cannot only be omitted but much better results obtained. The omission of this air space effects a saving in the outside walls of the building equal to the height of this air space. In large buildings, this is a very considerable saving.

Where insulation is used on the roof, it is only necessary to provide roof construction of sufficient structural strength to carry the load. Much cheaper construction can therefore be used when the roof is insulated. Costly roofs of hollow tile, cinder fill, etc. are not necessary.

Great improvement in living conditions under the roof is also obtained by the use of insulation, due to the fact that the intense heat of the sun in the summer time cannot penetrate through the roof to anywhere the extent that it does in the case of an uninsulated roof.

ENGINEERING SERVICE: The Union Fibre Co., Incorporated will gladly supply information regarding any type of roof not included in Table 1, and will furnish complete scientific analysis of any roof, or other insulation problems, upon request to the main office at Winona, Minn. This service is rendered without cost or obligation.

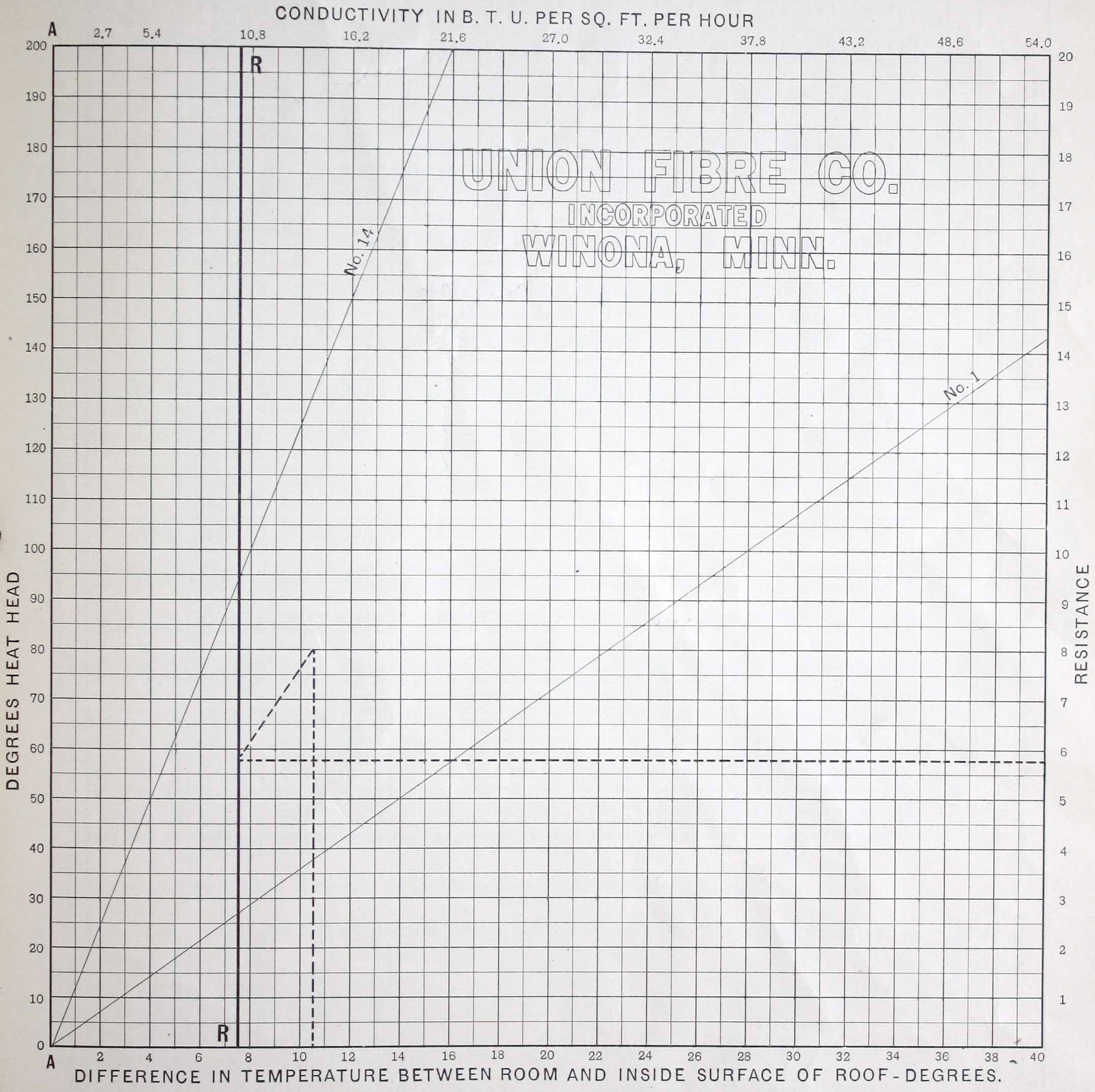


FIG. 5

Roof Resistance Curve

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TABLE No. 1

Conductivity and Resistance of Roofs, Uninsulated and Insulated with **FIBROFELT** or **LITH**

Roof No.	DESCRIPTION OF ROOF (5-Ply Tar and Gravel Roofing unless otherwise indicated by *)	Conductivity, "C," in B. t. u. per sq. ft., per degree difference in temperature, per hour, and Resistance, "R."																			
		Uninsulated		½″ Fibrofelt		¾″ Fibrofelt		1″ Fibrofelt		1¼″ Fibrofelt		1½″ Fibrofelt		2″ Lith		3″ Lith		4″ Lith		5″ Lith	
		C	R	C	R	C	R	C	R	C	R	C	R	C	R	C	R	C	R	C	R
1	⅞″ Boards—Soft Pine, Fir, Spruce, Etc.	0.382	2.616	0.241	4.135	0.204	4.895	0.178	5.655	0.156	6.415	0.138	7.175	0.127	7.891	0.102	9.741	0.079	12.671	0.063	15.816
2	1″ " " " " " " "	0.360	2.774	0.233	4.293	0.198	5.053	0.172	5.813	0.152	6.573	0.136	7.333	0.124	8.049	0.101	9.899	0.078	12.829	0.062	15.974
3	1¼″ " " " " " " "	0.323	3.091	0.217	4.610	0.186	5.370	0.163	6.130	0.145	6.890	0.131	7.650	0.120	8.366	0.098	10.216	0.076	13.146	0.061	16.291
4	1½″ " " " " " " "	0.292	3.416	0.203	4.935	0.176	5.695	0.155	6.455	0.139	7.215	0.125	7.975	0.115	8.691	0.095	10.541	0.074	13.471	0.060	16.616
5	1¾″ " " " " " " "	0.268	3.726	0.191	5.245	0.167	6.005	0.148	6.765	0.133	7.525	0.121	8.285	0.111	9.001	0.092	10.851	0.073	13.781	0.059	16.926
6	2″ " " " " " " "	0.247	4.038	0.179	5.557	0.158	6.317	0.141	7.077	0.127	7.837	0.116	8.597	0.107	9.313	0.090	11.163	0.071	14.093	0.058	17.238
7	2¼″ " " " " " " "	0.229	4.356	0.170	5.875	0.151	6.635	0.135	7.395	0.123	8.155	0.112	8.915	0.104	9.631	0.087	11.481	0.069	14.411	0.057	17.556
8	2½″ " " " " " " "	0.214	4.671	0.162	6.190	0.144	6.950	0.130	7.710	0.118	8.470	0.108	9.230	0.100	9.946	0.085	11.796	0.068	14.726	0.056	17.871
9	2¾″ " " " " " " "	0.200	4.986	0.154	6.505	0.138	7.265	0.125	8.025	0.114	8.785	0.105	9.545	0.098	10.261	0.083	12.111	0.066	15.041	0.055	18.186
10	3″ " " " " " " "	0.189	5.301	0.147	6.820	0.132	7.580	0.120	8.340	0.110	9.100	0.101	9.860	0.095	10.576	0.080	12.426	0.065	15.356	0.054	18.501
11	3½″ " " " " " " "	0.169	5.931	0.134	7.450	0.122	8.210	0.110	8.970	0.103	9.730	0.095	10.490	0.089	11.206	0.077	13.056	0.063	15.986	0.052	19.131
12	4″ " " " " " " "	0.152	6.566	0.124	8.085	0.113	8.845	0.104	9.605	0.097	10.365	0.090	11.125	0.084	11.841	0.073	13.691	0.060	16.621	0.051	19.766
13	5″ " " " " " " "	0.127	7.856	0.107	9.375	0.099	10.135	0.092	10.895	0.086	11.655	0.081	12.415	0.076	13.131	0.067	14.981	0.056	17.911	0.048	21.056
14	6″ " " " " " " "	0.109	9.096	0.094	10.615	0.088	11.375	0.082	12.135	0.077	12.895	0.073	13.655	0.070	14.371	0.062	16.221	0.052	19.151	0.044	22.296
15	⅞″ Boards—Hard Pine	0.412	2.425	0.254	3.944	0.212	4.704	0.183	5.464	0.161	6.224	0.143	6.984	0.130	7.700	0.105	9.550	0.080	12.480	0.064	15.625
16	1″ " " "	0.392	2.553	0.245	4.072	0.207	4.832	0.178	5.592	0.157	6.352	0.140	7.112	0.128	7.828	0.103	9.678	0.079	12.608	0.063	15.753
17	1¼″ " " "	0.355	2.816	0.231	4.335	0.196	5.095	0.171	5.855	0.151	6.615	0.136	7.375	0.123	8.091	0.100	9.941	0.078	12.871	0.062	16.016
18	1½″ " " "	0.325	3.076	0.218	4.595	0.187	5.355	0.164	6.115	0.146	6.875	0.131	7.635	0.120	8.351	0.098	10.201	0.076	13.131	0.061	16.276
19	1¾″ " " "	0.299	3.337	0.206	4.856	0.178	5.616	0.157	6.376	0.140	7.136	0.127	7.896	0.116	8.612	0.096	10.462	0.075	13.392	0.060	16.537
20	2″ " " "	0.278	3.596	0.196	5.115	0.170	5.875	0.151	6.635	0.135	7.395	0.122	8.155	0.113	8.871	0.093	10.721	0.073	13.661	0.060	16.796
21	2¼″ " " "	0.259	3.861	0.186	5.380	0.163	6.140	0.145	6.900	0.131	7.660	0.118	8.420	0.110	9.136	0.091	10.986	0.072	13.916	0.059	17.061
22	2½″ " " "	0.243	4.121	0.177	5.640	0.156	6.400	0.142	7.160	0.126	7.920	0.115	8.680	0.107	9.396	0.089	11.246	0.071	14.176	0.058	17.321
23	2¾″ " " "	0.228	4.381	0.170	5.900	0.150	6.660	0.135	7.420	0.122	8.180	0.112	8.940	0.103	9.656	0.087	11.506	0.069	14.436	0.057	17.581
24	3″ " " "	0.216	4.641	0.162	6.160	0.144	6.920	0.130	7.680	0.118	8.440	0.109	9.200	0.101	9.916	0.085	11.766	0.068	14.696	0.056	17.841
25	3½″ " " "	0.194	5.166	0.147	6.785	0.134	7.445	0.122	8.205	0.112	8.965	0.103	9.725	0.096	10.441	0.081	12.291	0.066	15.221	0.054	18.366
26	4″ " " "	0.176	5.681	0.139	7.200	0.126	7.960	0.115	8.720	0.105	9.480	0.098	10.240	0.091	10.956	0.078	12.806	0.064	15.736	0.053	18.881
27	5″ " " "	0.149	6.736	0.121	8.255	0.111	9.015	0.102	9.775	0.095	10.535	0.089	11.295	0.083	12.011	0.072	13.861	0.060	16.791	0.050	19.936
28	6″ " " "	0.129	7.776	0.108	9.295	0.100	10.055	0.093	10.815	0.086	11.575	0.081	12.335	0.077	13.051	0.067	14.901	0.056	17.831	0.048	20.976
29	1″ Concrete	0.594	1.685	0.313	3.204	0.252	3.964	0.212	4.724	0.182	5.484	0.160	6.244	0.144	6.960	0.113	8.810	0.085	11.740	0.067	14.885
30	2″ "	0.553	1.806	0.300	3.325	0.245	4.085	0.206	4.845	0.178	5.605	0.157	6.365	0.141	7.081	0.112	8.931	0.084	11.861	0.066	15.006
31	3″ "	0.518	1.928	0.289	3.447	0.238	4.207	0.201	4.967	0.174	5.727	0.154	6.487	0.138	7.203	0.110	9.053	0.083	11.983	0.066	15.128
32	4″ "	0.488	2.047	0.280	3.566	0.231	4.326	0.196	5.086	0.171	5.846	0.151	6.606	0.136	7.322	0.108	9.172	0.082	12.102	0.065	15.247
33	5″ "	0.456	2.191	0.269	3.710	0.224	4.470	0.191	5.230	0.166	5.990	0.148	6.750	0.134	7.466	0.107	9.316	0.081	12.246	0.065	15.391
34	6″ "	0.436	2.289	0.263	3.808	0.219	4.568	0.187	5.328	0.164	6.088	0.146	6.848	0.132	7.564	0.106	9.414	0.081	12.344	0.064	15.489
35	7″ "	0.415	2.411	0.254	3.930	0.213	4.690	0.183	5.450	0.161	6.210	0.143	6.970	0.130	7.686	0.104	9.536	0.080	12.466	0.064	15.611
36	8″ "	0.396	2.529	0.247	4.048	0.208	4.808	0.180	5.568	0.158	6.328	0.141	7.088	0.128	7.804	0.103	9.654	0.079	12.584	0.064	15.729
37	9″ "	0.377	2.651	0.240	4.170	0.202	4.930	0.175	5.690	0.155	6.450	0.138	7.210	0.126	7.926	0.102	9.776	0.079	12.706	0.063	15.851
38	10″ "	0.361	2.771	0.233	4.290	0.198	5.050	0.172	5.810	0.152	6.570	0.136	7.330	0.124	8.046	0.101	9.896	0.078	12.826	0.063	15.971
39	11″ "	0.347	2.886	0.227	4.405	0.194	5.165	0.168	5.925	0.149	6.685	0.134	7.455	0.122	8.161	0.100	10.011	0.077	12.941	0.062	16.086
40	12″ "	0.333	3.011	0.221	4.530	0.189	5.290	0.165	6.050	0.147	6.810	0.132	7.570	0.120	8.286	0.099	10.136	0.077	13.066	0.062	16.221
41	* Corrugated Steel on Purlins	1.870	0.535	0.487	2.054	0.355	2.814	0.280	3.574	0.231	4.334	0.196	5.094	0.172	5.810	0.131	7.660	0.094	10.590	0.073	13.735
42	* Corrugated Steel on ⅞″ Soft Pine Boards	0.512	1.953	0.288	3.472	0.236	4.232	0.200	4.992	0.174	5.752	0.154	6.512	0.138	7.228	0.110	9.078	0.090	11.008	0.066	15.153
43	* " " " 1″ " " "	0.473	2.111	0.276	3.630	0.227	4.390	0.194	5.150	0.169	5.910	0.150	6.670	0.135	7.386	0.108	9.236	0,082	12.166	0.065	15.311
44	* " " " 1¾″ " " "	0.327	3.059	0.218	4.578	0.187	5.338	0.164	6.098	0.145	6.858	0.131	7.618	0.120	8.334	0.098	10.184	0.076	13.144	0.061	16.259
45	* " " " 2″ " " "	0.296	3.375	0.204	4.894	0.177	5.654	0.156	6.414	0.139	7.174	0.126	7.934	0.115	8.650	0.095	10.500	0.074	13.430	0.060	16.575
46	* Corrugated Steel on ⅞″ Hard Pine Boards	0.568	1.760	0.306	3.279	0.248	4.039	0.208	4.799	0.180	5.559	0.158	6.319	0.142	7.035	0.112	8.885	0.085	11.815	0.067	14.960
47	* " " " 1″ " " "	0.529	1.890	0.293	3.409	0.240	4.169	0.203	4.929	0.176	5.689	0.154	6.449	0.139	7.165	0.111	9.015	0.084	11.945	0.066	15.090
48	* " " " 1¾″ " " "	0.373	2.673	0.238	4.192	0.202	4.952	0.175	5.712	0.154	6.472	0.138	7.232	0.126	7.948	0.102	9.798	0.079	12.728	0.063	15.873
49	* " " " 2″ " " "	0.341	2.933	0.225	4.452	0.192	5.212	0.167	5.972	0.148	6.732	0.133	7.492	0.122	8.208	0.099	10.058	0.077	12.988	0.062	16.133
50	* Wood Shingles on ⅞″ Hard Pine Boards	0.400	2.499	0.249	4.018	0.209	4.778	0.180	5.538	0.159	6.298	0.141	7.058	0.128	7.774	0.104	9.624	0.080	12.554	0.064	15.699
51	* Slate on ⅞″ Hard Pine Boards	0.418	2.339	0.259	3.858	0.216	4.618	0.186	5.378	0.163	6.138	0.145	6.898	0.131	7.614	0.106	9.464	0.081	12.394	0.064	15.539
52	* " " 1″ " " "	0.405	2.469	0.250	3.988	0.210	4.748	0.181	5.508	0.159	6.268	0.142	7.028	0.129	7.744	0.104	9.594	0.080	12.524	0.064	15.669
53	* " " 1¾″ " " "	0.308	3.252	0.209	4.771	0.181	5.531	0.159	6.291	0.142	7.051	0.128	7.811	0.117	8.527	0.096	10.377	0.075	13.307	0.061	16.452
54	* " " 2″ " " "	0.285	3.513	0.198	5.032	0.172	5.792	0.152	6.552	0.136	7.312	0.124	8.072	0.114	8.788	0.094	10.638	0.074	13.568	0.060	16.713
55	⅞″ Hard Pine Boards—Air Space, Plaster (See Note A)	0.200	5.000	0.153	6.519	0.137	7.279	0.124	8.039	0.113	8.799	0.104	9.559	0.097	10.275	0.082	12.125	0.066	15.055	0.055	18.200
56	2″ Concrete on 6″ Hollow Tile	0.400	2.500	0.249	4.019	0.209	4.779	0.181	5.539	0.159	6.299	0.141	7.059	0.128	7.775	0.104	9.625	0.080	12.555	0.064	15.700
57	2″ Concrete on 8″ Hollow Tile	0.360	2.777	0.233	4.296	0.198	5.056	0.172	5.816	0.152	6.576	0.136	7.336	0.124	8.052	0.101	9.902	0.078	12.832	0.063	15.977
58	6″ Hollow Tile	0.442	2.259	0.265	3.778	0.220	4.538	0.189	5.298	0.165	6.058	0.146	6.818	0.132	7.534	0.116	9.384	0.081	12.314	0.065	15.459
59	8″ Hollow Tile	0.394	2.536	0.247	4.055	0.207	4.815	0.179	5.575	0.158	6.335	0.141	7.095	0.128	7.811	0.103	9.661	0.079	12.591	0.064	15.736

NOTE: Surface effects have been considered in calculating all conductivities and resistances.

NOTE A: Resistance is the same regardless of thickness of air space except that as the thickness increases, the resistance is decreased by convection currents. The figures given are for plaster on bottom of roof joists.

INFORMATION SHEET

Union Fibre Co., Incorporated,
Winona, Minn.

Gentlemen:

Kindly prepare and submit to us as soon as possible a scientific analysis showing the kind and thickness of insulation needed to accomplish the maximum economy of fuel consumption and radiation, and to eliminate condensation, or "sweating" under the following roof:

1. Name of particular job.
2. Location.
3. Type of roof.
4. Materials and Construction. (Details of roof construction, thickness, etc.)
5. Area of roof.
6. Temperature maintained beneath roof during heating season.
7. Humidity beneath roof.
8. Will steam vapor be given off by the process conducted beneath roof?
9. Size, number and kind of openings in roof.
10. Do you wish a quotation on the necessary insulation?
11. Do you wish detail specifications for the application of insulation and roofing?

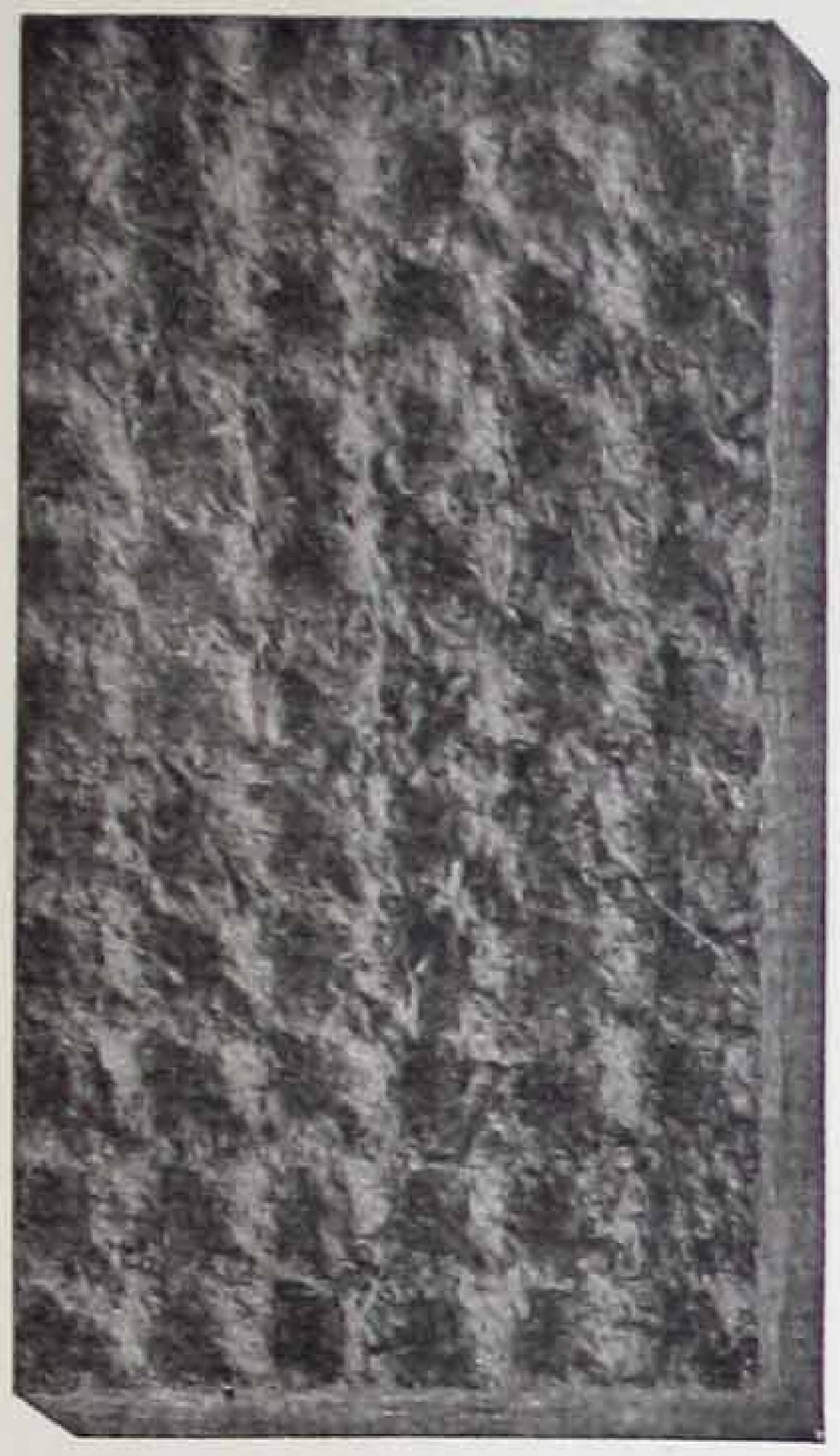
It is, of course, understood that your services in this matter are without charge or obligation on our part.

Firm Name..

Address..

City...State..............................

By..



FIBROFELT

Fibrofelt is a flexible board used for insulation and sound deadening purposes in all styles of buildings. It is made from carefully selected Flax and Grain straw fibres, which have been cooked, sterilized, worked into a board, or felt, then dried under high pressure. The resulting product is a board of high insulating value; flexible, yet firm enough to be handled and sawed like lumber. It is easily flanged on the job to fit into valleys.

LITH

Lith is a waterproof board form of insulation used in refrigeration work as well as for roof insulation. The only substances used in its manufacture are flax fibres, limestone rock wool, and waterproofing compound. The flax fibres are cooked and separated by combing machines before they are mingled with the rock wool. They have great strength, besides their insulating qualities. The resulting board has great tensile strength, very low heat conductivity, and is of unusual compressive strength and firmness. Owing to this last quality, it is a perfectly safe insulation for use under all forms of roofing.

Roofing can safely be laid directly on either Fibrofelt or Lith. No false roof is required as with soft forms of insulation such as quilted forms.

Products

of the

UNION FIBRE CO.

INCORPORATED

LINOFELT

An Insulating Quilt

FIBROFELT

An Insulating Panel

LITH

A Water-proof Insulating Board

UNION PIPE COVERING

ACOUSTICAL FELTS AND BOARDS

For the Acoustical Correction of Auditoriums, Etc.

MINERAL WOOL

Pure Limestone Rock Wool

UPHOLSTERY TOW

REFRIGERATOR DOORS AND WINDOWS

INSULATION ACCESSORIES

Engineering advice concerning the uses of these products
cheerfully furnished on request.

UNION FIBRE CO., Inc., WINONA, MINNESOTA